



I-95 Corridor Coalition

I-95 Corridor Coalition Vehicle Probe Project: Validation of INRIX Data

Monthly Report: Rhode Island



May 2012

I-95 CORRIDOR COALITION VEHICLE PROBE PROJECT VALIDATION OF DATA QUALITY

APRIL 2012

Monthly Report

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May 2012

Evaluation Results for the State of Rhode Island

Executive Summary

The data from the Vehicle Probe Project is validated using Bluetooth™ Traffic Monitoring (BTM) technology on a near monthly basis. Travel time samples were collected in Rhode Island along approximately 25 freeway miles from Monday, April 2, 2012 through Saturday, April 14, 2012. BTMs sensor were deployed on the beginning and ending points of ten different segments along I-95 corridor in Rhode Island. Specifically, the study area stretches from I-95 exit 1 (RI-3) in the south (Washington County) to I-95 exit 16 (RI-10) in the north (Providence County). Travel time data was collected for both directions along the freeway with the assistance of Rhode Island Department of Transportation (RIDOT) personnel. The dataset collected represents approximately 1076 hours of observations along 10 freeway segments, totaling approximately 25 miles.

ES Table 1 summarizes the results of the comparison between the validation data and the INRIX data for freeway segments during the above noted periods. As shown, the average absolute speed error (AASE) and Speed Error Bias (SEB) were within specification for all speed bins. Even when errors are measured against the mean (rather than the SEM band) the data meets contract specifications for the AASE in all speed bins.

ES Table 1 - Rhode Island Evaluation Summary						
Speed Bin	Absolute Speed Error (<10mph)		Speed Error Bias (<5mph)		Number of 5 Minute Samples	Hours of Data Collection
	Comparison with SEM Band	Comparison with Mean	Comparison with SEM Band	Comparison with Mean		
0-30 MPH	4.2	5.2	2.8	2.9	29	2.4
30-45 MPH	7.8	10.0	4.9	5.9	116	9.7
45-60 MPH	2.5	5.5	2.1	5.0	1008	84.0
>60 MPH	1.2	3.5	-0.7	-1.5	11758	979.8
All Speeds	1.4	3.7	-0.4	-0.9	12911	1075.9

Based upon data collected from April 2nd, 2012 through April 14, 2012 across 25 miles of roadway.

As part of the on-going validation process, vehicle probe data from each state is validated on a rotating basis. This is the first time that data has been validated in Rhode Island. As additional validation is performed, a summary of the cumulative validation effort will be provided.

Data Collection

The data from the Vehicle Probe Project is validated using Bluetooth™ Traffic Monitoring (BTM) technology on a near monthly basis. BTMs sensor were deployed on the beginning and ending points of ten segments along I-95 corridor in Rhode Island. The study area stretches from I-95 exit 1 (RI-3) in the south to I-95 exit 16 (RI-10) in the north. Travel time data was collected for both directions along the freeway. The data was collected between April 2, 2012 and April 14, 2012 with the assistance of Rhode Island Department of Transportation (RIDOT) personnel. This round of data collections in Rhode Island was designed to capture the traffic data on a sample of freeways. Segment locations are chosen with a high-likelihood of observing recurrent and non-recurrent congestions during peak or off-peak periods.

Figure 1 presents an overview snapshot of the roadway segments over which Bluetooth sensors were deployed along the I-95 corridor in Rhode Island. Blue segments represent freeway segments selected for analysis.

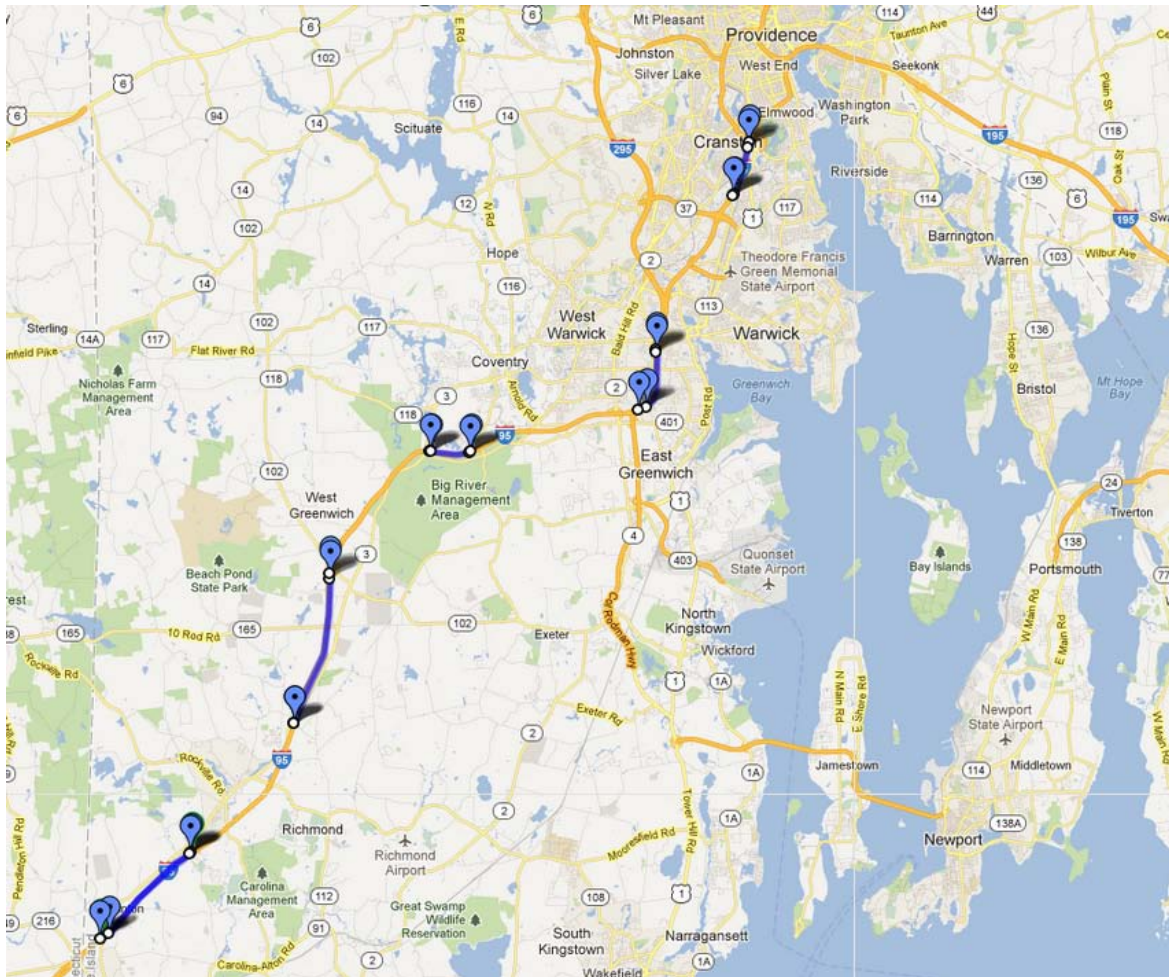


Figure 1 — Locations of all segments selected for analysis in Rhode Island

TMC segments selected for validation in Rhode Island

Table 1 presents a list of data collection segments from Rhode Island. In total, these segments cover a total length of approximately 25 freeway miles. Data collection segments are comprised of one or more Traffic Message Channel (TMC) base segments, such that total length of the data collection segment is one mile long or greater for freeways. When appropriate, consecutive TMC segments are combined to form a data collection segment longer than one mile. The results of validation performed on ten freeway segments are included in this report. Table 1 contains summary information on each data collection segment. The latitude/longitude coordinates of the locations at which the Bluetooth sensors were deployed throughout the state of Rhode Island are provided in Table 1 as well as an active map link to view the data collection segment in detail. Click on the map link to see a detailed map for the respective data collection segment. It should be noted that the configuration of test segments is often such that the endpoint of one segment coincides with the start point of the next segment, so that one Bluetooth sensor covers both data collection segments.

Table 1 also provides data on the precise length of the TMCs comprising the test segment as compared to the measured length between BluetoothTM Traffic Monitoring (BTM) sensors placed on the roadway. Details of the algorithm used to estimate equivalent path travel times based on INRIX data feeds for individual data collection segments are provided in a separate report. This algorithm finds an equivalent INRIX travel time (and therefore travel speed) corresponding to each sample BTM travel time observation on the test segment of interest.

Table 1
Segments selected for validation in Rhode Island

SEGMENT (Map Link)	DESCRIPTION			TMC CODES		Deployment		Length % Diff
	Highway Direction	State County	Starting at Ending at	Begin End	Number Length	Begin Lat/Lon End Lat/Lon		
FREEWAYS								All Lengths in Miles
F1 (129+04681)	I-95	Rhode Island	Woodville Alton Rd/Exit 2	129+04681	1	41.450614	-71.782191	3.29
	NB	Washington	RI-3/Exit 1	129+04681	3.4	41.484294	-71.735865	-2.14%
F2 (129+04684)	I-95	Rhode Island	RI-102/Exit 5	129+04684	1	41.53796	-71.678647	4.50
	NB	Kent	RI-3/Exit 4	129+04684	4.3	41.597995	-71.658947	4.00%
F3 (129+04686)	I-95	Rhode Island	Hopkins Hill Rd/Exit 6A	129+04686	1	41.650638	-71.603252	1.13
	NB	Kent	RI-3/Exit 6	129+04686	1.1	41.650474	-71.581402	-1.12%
F4 (129+04690)	I-95	Rhode Island	RI-117/Centerville Rd/Exit 9	129+04690	1	41.669079	-71.482784	1.82
	NB	Kent	RI-4/Exit 9	129+04690	1.7	41.692753	-71.476723	5.45%
F5 (129+04696)	I-95	Rhode Island	RI-10/Exit 16	129+04696	1	41.757486	-71.434012	1.44
	NB	Providence	Jefferson Blvd/Exit 15	129+04696	1.5	41.778814	-71.425466	-6.51%
F6 (129-04695)	I-95	Rhode Island	Jefferson Blvd/Exit 15	129-04695	1	41.776818	-71.42643	1.58
	SB	Kent	RI-10/Exit 16	129-04695	1.4	41.756973	-71.434774	9.61%
F7 (129-04689)	I-95	Rhode Island	RI-4/Exit 9	129-04689	1	41.692001	-71.477234	1.88
	SB	Kent	RI-117/Centerville Rd/Exit 9	129-04689	1.9	41.668329	-71.487449	0.03%
F8 (129-04685)	I-95	Rhode Island	RI-3/Exit 6	129-04685	1	41.651095	-71.579907	1.31
	SB	Kent	Hopkins Hill Rd/Exit 6A	129-04685	1.2	41.650781	-71.603026	7.82%
F9 (129-04683)	I-95	Rhode Island	RI-3/Exit 4	129-04683	1	41.600028	-71.658986	4.51
	SB	Washington	RI-102/Exit 5	129-04683	4.5	41.537935	-71.678826	0.92%
F10 (129-04680)	I-95	Rhode Island	RI-3/Exit 1	129-04680	1	41.484129	-71.736501	3.71
	SB	Washington	Woodville Alton Rd/Exit 2	129-04680	3.6	41.448385	-71.786637	2.85%
TOTALS				-	10	-	-	25.17
				-	24.7	-	-	-

Analysis of Freeway Results

Table 2 summarizes the data quality measures obtained as a result of comparison between Bluetooth and all reported INRIX speeds. Specifications include the Average Absolute Speed Error (AASE) and the Speed Error Bias (SEB).

Average Absolute Speed Error (AASE)

The AASE is defined as the mean absolute value of the difference between the mean speed reported from the VPP and the ground truth mean speed for a specified time period. The AASE is the primary accuracy metric. Based on the contract specifications, the speed data from the VPP shall have a maximum average absolute error of 10 miles per hour (MPH) in each of four speed ranges: 0-30 MPH, 30-45 MPH, 45-60 MPH, and > 60 MPH.

Speed Error Bias (SEB)

The SEB is defined as the average speed error (not the absolute value) in each speed range. SEB is a measure of whether the speed reported in the VPP consistently under or over estimates speed as compared to ground truth speed. Based on the contract specifications, the VPP data shall have a maximum SEB of +/- 5 MPH in each of speed ranges as defined above.

The results are presented as compared against the mean of the ground truth data as well as the 95th percent confidence interval for the mean, referred to as the Standard Error of the Mean (SEM) band. The SEM band takes into account any uncertainty in the ground truth speed as measured by BTM equipment due to limited samples and/or data variance. Contract specifications are assessed against the SEM band. (See the *Vehicle Probe Project: Data Use and Application Guide* for additional details on the validation process.) The AASE in the lower two speed bands have proven to be the critical specification (and most difficult) to attain, and are highlighted in Table 2. AASE below 10 MPH meet contract specifications. AASE below 5 MPH are considered exceptional quality. **As shown, the average absolute speed error (AASE) and Speed Error Bias (SEB) were within specification for all speed bins.**

TABLE 2
Data quality measures for freeway segments greater than one mile in Rhode Island

SPEED BIN	Data Quality Measures for				No. of 5 Minute Samples	Hours of Data Collection
	1.96 SEM Band		Mean			
	SEB <5 mph (contract specifications)	AASE <10 mph	SEB	AASE		
0-30	2.8	4.2	2.9	5.2	29	2*
30-45	4.9	7.8	5.9	10.0	116	10*
45-60	2.1	2.5	5.0	5.5	1008	84
60+	-0.7	1.2	-1.5	3.5	11758	980

*Results in the specified row may not be reliable due to small number of observations

Table 3 shows the percentage of the time INRIX data falls within 5 mph of the SEM band and the mean for each speed bin for all freeway data segments in Rhode Island.

Table 3
Percent observations meeting data quality criteria for freeway segments greater than one mile in Rhode Island

SPEED BIN	Data Quality Measures for				No. of Obs.
	1.96 SEM Band		Mean		
	Percentage falling inside the band	Percentage falling within 5 mph of the band	Percentage equal to the mean	Percentage within 5 mph of the mean	
0-30	24%	69%	0%	66%	29*
30-45	7%	37%	0%	25%	116
45-60	32%	85%	0%	53%	1008
60+	58%	93%	0%	75%	11758

*Results in the specified row may not be reliable due to small number of observations

The Score metric in the VPP data provides an indication on whether speed data is based on real-time information or relies primarily on historical data. Three discrete values correspond to:

- “30” – high confidence, based on real-time time data for that specific segment
- “20” – medium confidence, based on real-time data across multiple segments and/or based on a combination of expected and real-time data
- “10” – low confidence, based primarily on historical data

Score less than “30” is an indication of reliance on some type of historical data or averaging of data across a broad geographic area. Table 4 presents AASE and SEB data on reported INRIX speeds with a score less than 25, greater than or equal to 25, and for all Score values. (Note that although Score is a discrete value of 10, 20, or 30 for any given TMC segment at a given time, aggregating the data from multiple TMC segments over time creates rational values of Score between 10 and 30.)

Table 4
Data quality measures by Score Value for INRIX speed data
on freeway segment in Rhode Island

SPEED BIN	SCORE	Data Quality Measures for				No. of Obs.
		1.96 SEM Band		Mean		
		Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
0-30	< 25	-	-	-	-	0
	>= 25	2.8	4.2	2.9	5.2	29*
	ALL	2.8	4.2	2.9	5.2	29*
30-45	< 25	-	-	-	-	0
	>= 25	4.9	7.8	5.9	10.0	116
	ALL	4.9	7.8	5.9	10.0	116
45-60	< 25	0.6	0.6	3.1	3.1	39
	>= 25	2.1	2.6	5.0	5.6	969
	ALL	2.1	2.5	5.0	5.5	1008
60+	< 25	-1.4	1.4	-3.9	4.4	268
	>= 25	-0.6	1.2	-1.5	3.5	11490
	ALL	-0.7	1.2	-1.5	3.5	11758

*Results in the specified row may not be reliable due to small number of observations

Tables 5 and 6 present detailed data for individual TMC segments in Rhode Island in a similar format as Tables 2 and 3, respectively. Note that for some segments and in some speed bins the comparison results may not be reliable due to small number of observations.

Table 5
Data quality measures for individual freeway validation segments greater than one mile in the state of Rhode Island

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SEM Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
129+04681	3.36	3.29	0-30	--	--	--	--	0
			30-45	--	--	--	--	0
			45-60	3.6	3.6	8.2	8.2	2*
			60+	-1.0	1.3	-2.4	3.6	1409
129+04684	4.33	4.50	0-30	--	--	--	--	0
			30-45	4.9	4.9	23.0	23.0	2*
			45-60	1.4	1.4	7.7	7.7	50
			60+	-1.7	1.9	-3.3	4.5	1183
129+04686	1.14	1.13	0-30	--	--	--	--	0
			30-45	--	--	--	--	0
			45-60	1.2	1.2	6.7	6.7	4*
			60+	-1.4	1.6	-3.5	4.6	1188
129+04690	1.73	1.82	0-30	--	--	--	--	0
			30-45	11.9	11.9	13.4	13.4	2*
			45-60	2.7	2.7	5.6	5.7	104
			60+	0.0	0.8	-0.2	2.7	1519
129+04696	1.54	1.44	0-30	2.5	4.0	2.5	4.9	28*
			30-45	0.8	5.7	0.7	7.4	70
			45-60	1.4	2.2	3.7	4.7	488
			60+	-0.3	1.1	-0.7	3.2	1464
129-04680	3.61	3.71	0-30	11.5	11.5	13.3	13.3	1*
			30-45	10.1	10.1	12.9	13.4	9*
			45-60	4.2	4.2	8.7	8.7	8*
			60+	-0.3	0.9	-0.7	3.0	1478
129-04683	4.47	4.51	0-30	--	--	--	--	0
			30-45	--	--	--	--	0
			45-60	0.4	0.4	12.3	12.3	9*
			60+	-0.6	1.0	-1.5	3.3	906
129-04685	1.22	1.31	0-30	--	--	--	--	0
			30-45	--	--	--	--	0
			45-60	3.6	3.6	12.2	12.2	3*
			60+	-1.7	1.9	-4.0	4.9	981
129-04689	1.88	1.88	0-30	--	--	--	--	0
			30-45	15.6	15.6	18.4	18.4	5*
			45-60	4.0	4.0	6.7	6.7	90
			60+	0.5	0.8	1.1	2.4	962

*Results in the specified row may not be reliable due to small number of observations

Table 5 (Cont'd)
Data quality measures for individual freeway validation segments greater than one mile in the state of Rhode Island

TMC	Standard TMC length	Bluetooth distance	SPEED BIN	Data Quality Measures for				No. of Obs.
				1.96 SEM Band		Mean		
				Speed Error Bias	Average Absolute Speed Error	Speed Error Bias	Average Absolute Speed Error	
129-04695	1.44	1.58	0-30	--	--	--	--	0
			30-45	11.1	11.1	12.7	12.7	28*
			45-60	2.7	2.7	5.4	5.5	250
			60+	0.1	0.7	0.3	2.7	668

*Results in the specified row may not be reliable due to small number of observations

Table 6
Observations meeting data quality criteria for individual freeway validation segments
greater than one mile in the state of Rhode Island

TMC	SPEED BIN	Data Quality Measures for								No. of Obs.
		1.96 SEM Band				Mean				
		Speed Error Bias		Average Absolute Speed Error		Speed Error Bias		Average Absolute Speed Error		
		No. falling inside the band	% falling inside the band	No. falling within 5 mph of the band	% falling within 5 mph of the band	No. equal to the mean	% equal to the mean	No. within 5 mph of the mean	% within 5 mph of the mean	
129+04681	0-30	--	--	--	--	--	--	--	--	0
	30-45	--	--	--	--	--	--	--	--	0
	45-60	0	0%	1	50%	0	0%	0	0%	2*
	60+	779	55%	1305	93%	0	0%	1019	72%	1409
129+04684	0-30	--	--	--	--	--	--	--	--	0
	30-45	1	50%	1	50%	0	0%	0	0%	2*
	45-60	24	48%	48	96%	0	0%	19	38%	50
	60+	564	48%	1020	86%	1	0%	719	61%	1183
129+04686	0-30	--	--	--	--	--	--	--	--	0
	30-45	--	--	--	--	--	--	--	--	0
	45-60	2	50%	4	100%	0	0%	1	25%	4*
	60+	638	54%	1053	89%	0	0%	718	60%	1188
129+04690	0-30	--	--	--	--	--	--	--	--	0
	30-45	0	0%	0	0%	0	0%	0	0%	2*
	45-60	19	18%	87	84%	0	0%	42	40%	104
	60+	901	59%	1482	98%	2	0%	1303	86%	1519
129+04696	0-30	7	25%	20	71%	0	0%	19	68%	28*
	30-45	4	6%	33	47%	0	0%	24	34%	70
	45-60	180	37%	435	89%	0	0%	315	65%	488
	60+	913	62%	1377	94%	0	0%	1188	81%	1464
129-04680	0-30	0	0%	0	0%	0	0%	0	0%	1*
	30-45	3	33%	4	44%	0	0%	3	33%	9*
	45-60	2	25%	4	50%	0	0%	0	0%	8*
	60+	964	65%	1410	95%	0	0%	1216	82%	1478
129-04683	0-30	--	--	--	--	--	--	--	--	0
	30-45	--	--	--	--	--	--	--	--	0
	45-60	7	78%	9	100%	0	0%	0	0%	9*
	60+	587	65%	858	95%	0	0%	715	79%	906
129-04685	0-30	--	--	--	--	--	--	--	--	0
	30-45	--	--	--	--	--	--	--	--	0
	45-60	1	33%	2	67%	0	0%	0	0%	3*
	60+	485	49%	853	87%	0	0%	559	57%	981
129-04689	0-30	--	--	--	--	--	--	--	--	0
	30-45	0	0%	0	0%	0	0%	0	0%	5*
	45-60	9	10%	63	70%	0	0%	29	32%	90
	60+	568	59%	936	97%	1	0%	869	90%	962
129-04695	0-30	--	--	--	--	--	--	--	--	0
	30-45	0	0%	5	18%	0	0%	2	7%	28*
	45-60	75	30%	201	80%	0	0%	127	51%	250
	60+	457	68%	640	96%	0	0%	570	85%	668

*Results in the specified row may not be reliable due to small number of observations